

What is Claimed is:

1. Apparatus responsive to movement of a patient positioned on a patient positioning assembly during treatment/diagnosis, said apparatus comprising:

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5 camera means generating digital image signals representing an image of at least one passive fiducial <sup>having a Lambertian surface</sup> on said patient; and

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a  
10 processing means comprising <sup>means</sup> responsive to actual shape, appearance and lighting conditions of said at least one passive fiducial <sup>having a Lambertian surface</sup> and said image represented by said digital image signals to determine successive positions of said at least one passive fiducial <sup>having a Lambertian surface</sup>, means repetitively determining movement of said at least one passive fiducial <sup>having a Lambertian surface</sup> from said successive positions, and means generating an output in response to predetermined values of said movement.

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14 2. The apparatus of Claim <sup>23</sup>1, wherein said means generating an output includes means generating an indication of movement relative to at least one selected level of displacement.

15 17 3. The apparatus of Claim <sup>14</sup>2, wherein said means generating said indication of movement includes means providing a warning that said movement exceeds a first displacement and means providing a signal for terminating radiation <sup>treatment/diagnosis</sup> treatment when said movement exceeds a second displacement greater than said first displacement.

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20 16 4. The apparatus of Claim <sup>14</sup>3, wherein said means generating an indication of movement comprises display means generating an image of said fiducials and an indication of said movement relative to said first and second displacements.

125. The apparatus of Claim <sup>16</sup>4, wherein said camera means includes means generating digital image signals for a plurality of fiducials, said means repetitively determining movement determines movement of each of said plurality of fiducials, and said display means includes indicator means indicating a fiducial with the greatest movement.

18 8. The apparatus of Claim <sup>14</sup>2, wherein said means repetitively determining movement includes means detecting movement associated with patient breathing and random movement, and wherein said means generating an indication of movement indicates said random movement.

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3 1. The apparatus of Claim <sup>22 2</sup>1, wherein said means repetitively determining movement of said at least one ~~passive~~ fiducial includes means detecting movement associated with patient breathing, and said output means comprises means generating a gating signal synchronized to said patient breathing.

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4 8. The apparatus of Claim <sup>22 2</sup>1, wherein said processing means comprises means repetitively applying multiple levels of filtering to said digital image signals to determine successive positions of said at least one ~~passive~~ fiducial.

5 9. The apparatus of Claim <sup>4</sup>8, wherein said means applying multiple levels of filtering includes means applying bracketing and interpolation to said digital image signals to determine position of said at least one fiducial.

6 10. The apparatus of Claim <sup>4</sup>8, wherein said means applying multiple levels of filtering includes means applying minima suppression to said digital image signals.

7 11. The apparatus of Claim <sup>4</sup>8, wherein said means applying multiple levels of filtering include means applying at least two types of filtering selected from a group consisting of correlation, sparse sampling, bracketing and interpolation, and minima suppression.

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8 12. The apparatus of Claim <sup>7</sup>11, wherein said processing means includes means using multiple levels of resolution of said digital image signals to determine successive positions of at least one ~~passive~~ fiducial and said means applying multiple levels of filtering comprise means applying filtering at each of said multiple levels of resolution.

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9 ~~13.~~ The apparatus of Claim ~~8~~, wherein said processing means includes means using at least one of templates and interest operators to determine successive positions of said at least one fiducial from said digital image signals.

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10 ~~14.~~ The apparatus of Claim ~~1~~, wherein said processing means comprises means using a template to successively determine position of said at least one ~~passive~~ fiducial and means selecting said template.

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15 ~~15.~~ The apparatus of Claim ~~14~~, wherein said means selecting said template includes a display means, means generating on said display means an image of said at least one passive fiducial from said digital image signals and user interface means for selection of a template from said image of said at least one passive fiducial.

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10 ~~16.~~ The apparatus of Claim ~~14~~, wherein said at least one ~~passive~~ fiducial comprises a plurality of ~~passive~~ fiducials, and said means selecting a template includes means generating an initial template, means generating template matches for each of said plurality of ~~passive~~ fiducials from said digital image signals using said initial template, and means selecting one of said template matches for use in determining positions of each of said plurality of fiducials.

15 ~~17.~~ The apparatus of Claim ~~16~~, wherein said means selecting said one of said template matches includes means generating a value for each of said templates matches, and means selecting a template match having a median value as said one template match.

20 ~~18.~~ The apparatus of Claim ~~1~~ wherein said at least one passive fiducial comprises a fiducial having a Lambertian surface.

25 ~~19.~~ Apparatus responsive to movement of a patient positioned on a patient positioning assembly, said apparatus comprising:

camera means generating digital image signals representative of an image of said patient; and

processing means comprising means determining movement of said patient from said digital image signals, including movement associated with breathing by said patient, and gating means generating gating signals synchronized with said movement associated with breathing by said patient for actuating said beam generating means in synchronism with patient breathing.

~~21~~ ~~20~~. The apparatus of Claim ~~19~~ <sup>20</sup>, wherein said camera means generates said digital image signals representing an image of at least one fiducial on said patient, and said means determining movement of said patient includes means determining movement of said at least one fiducial.

5      ~~27~~ ~~21~~. The apparatus of Claim ~~19~~ <sup>20</sup> adapted for use during treatment of said patient with a radiation beam generated by a beam generator, wherein said gating means comprises means generating said gating signals synchronized to actuate said beam generator in synchronism with patient breathing.

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